$PM_{2.5}$ Characterization for Low NO_x Coal Combustion

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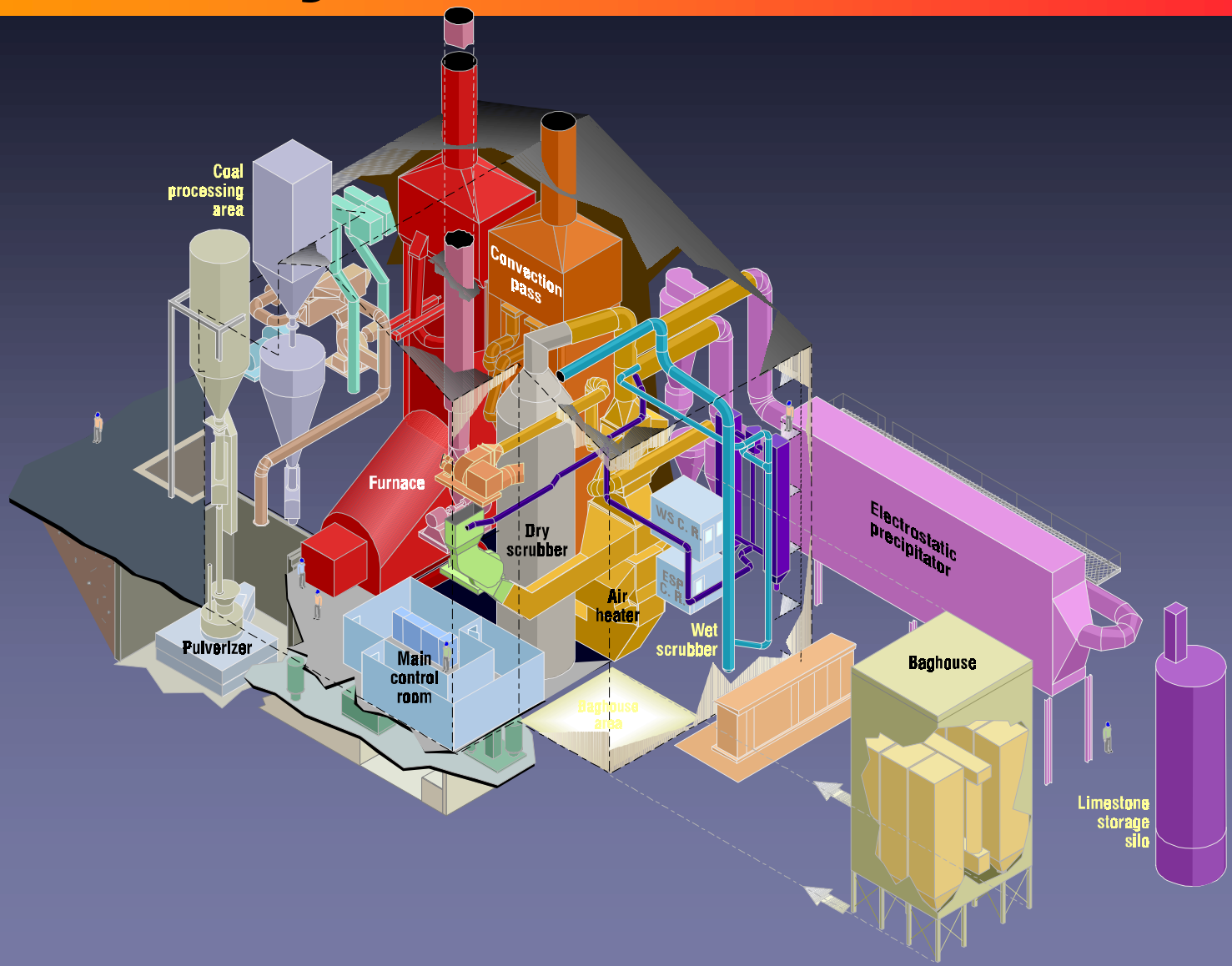
Program Sponsors

- US DOE- National Energy Technology Laboratory
- Babcock & Wilcox Company
- McDermott Techology, Inc.

Purpose

- Determine changes to fly ash and emissions due to ultra low-NO_x combustion
  - Composition
  - ESP performance
  - $PM_{2.5}$

Overall Layout of the CEDF



Test Conditions - Burner

- 100 million Btu/hr firing rate
- High Sulfur Coal - 4.3% S, 8.5% ash
- Low-NO_x
  - 0.4 lb NO_x/million Btu, SR = 1.17
- Ultra Low-NO_x
  - 0.2 lb NO_x/million Btu unstaged, SR = 1.17
  - 0.15 lb NO_x/million Btu staged, SR = 0.85/1.17

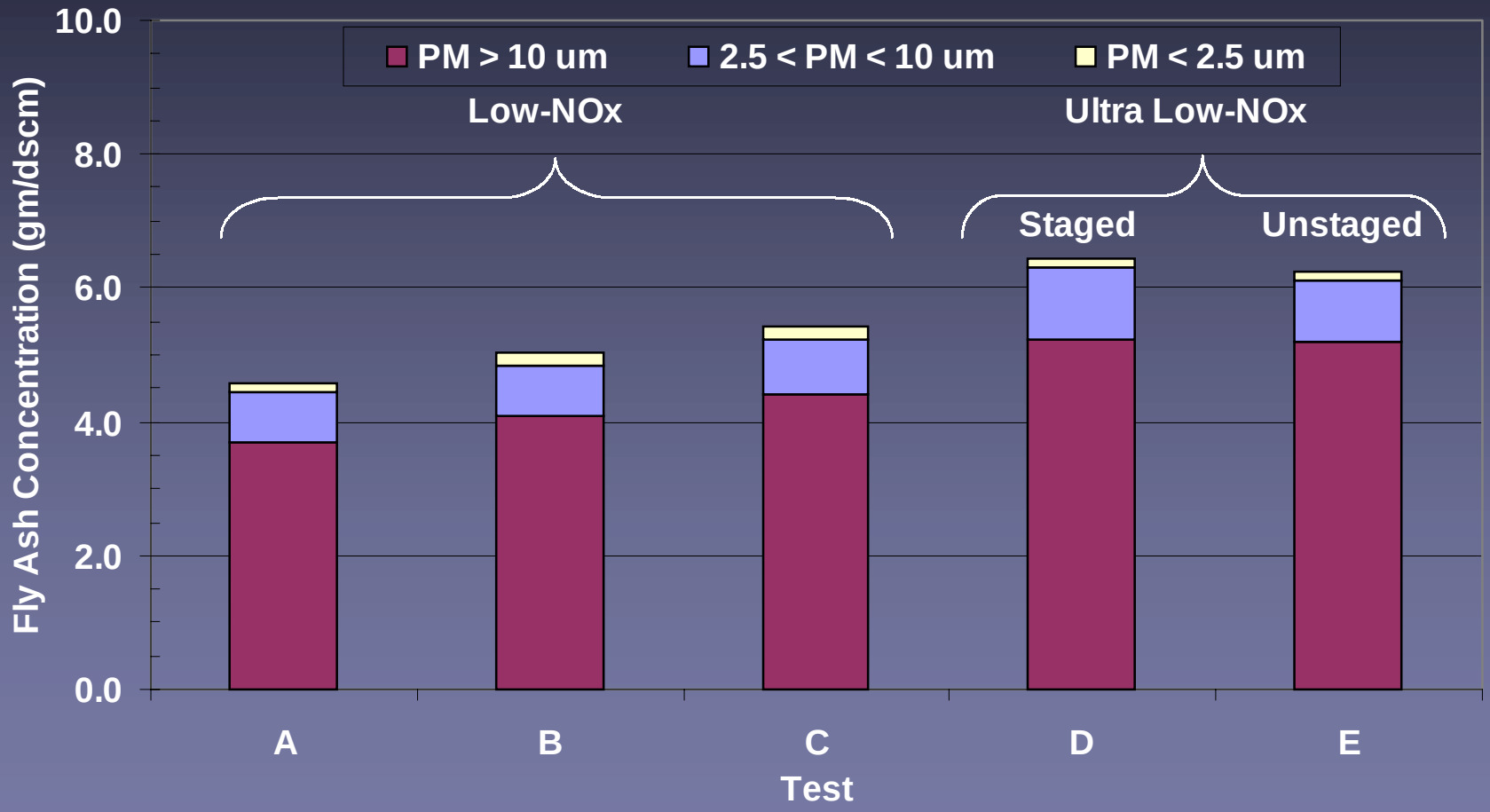
Test Conditions - ESP

- ~325^{0}F gas temperature
- Low-NO_x
  - 2 and 3 ESP fields
  - Different field voltage
- Ultra low-NO_x
  - Repeat one low-NO_x condition

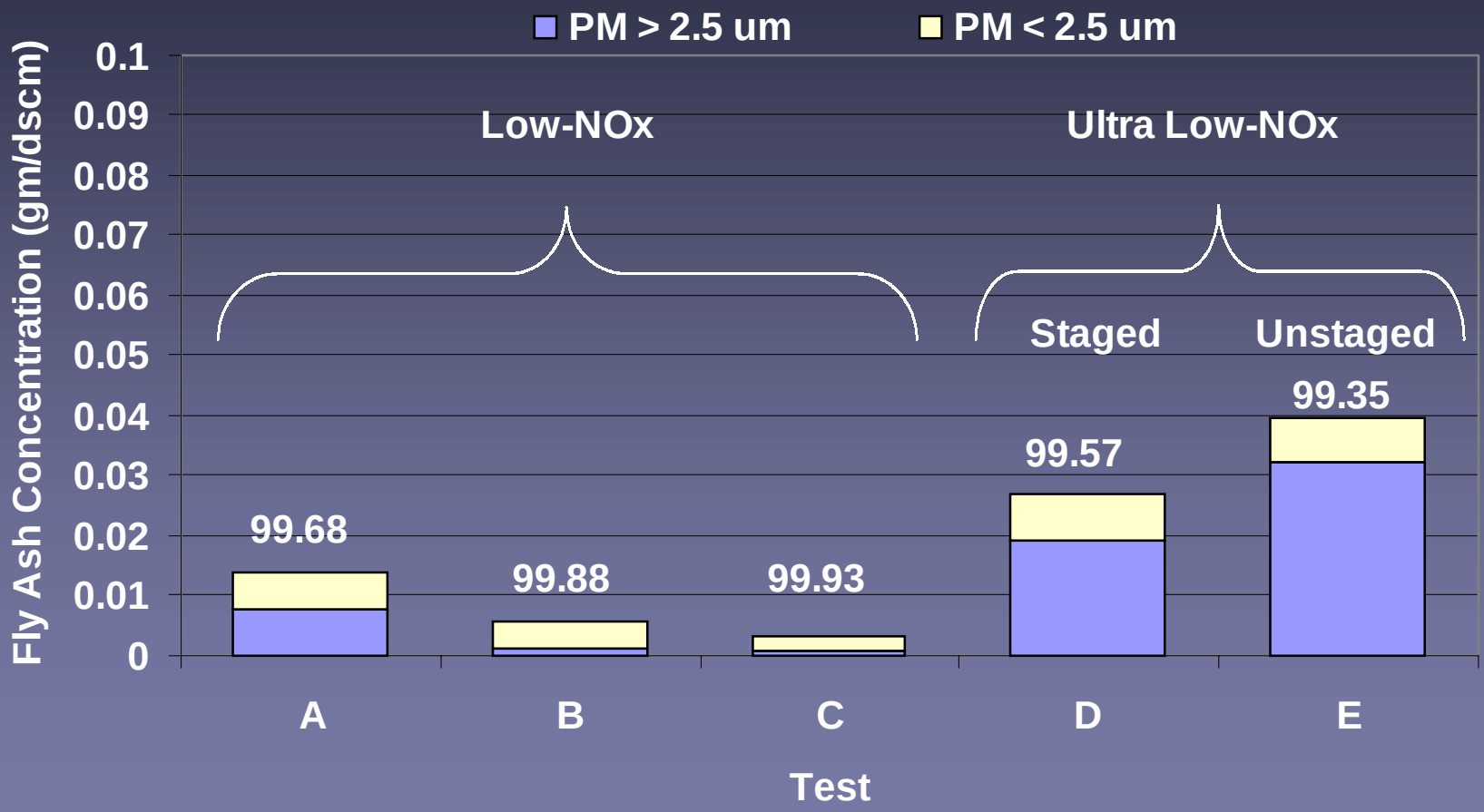
Chemical Analyses

- By size range
  - PM_{10} and $PM_{2.5}$ cyclones
- By analysis technique
  - Major elements - ICP
  - Trace elements - GFAA or CVAA
  - Other - carbon, ions

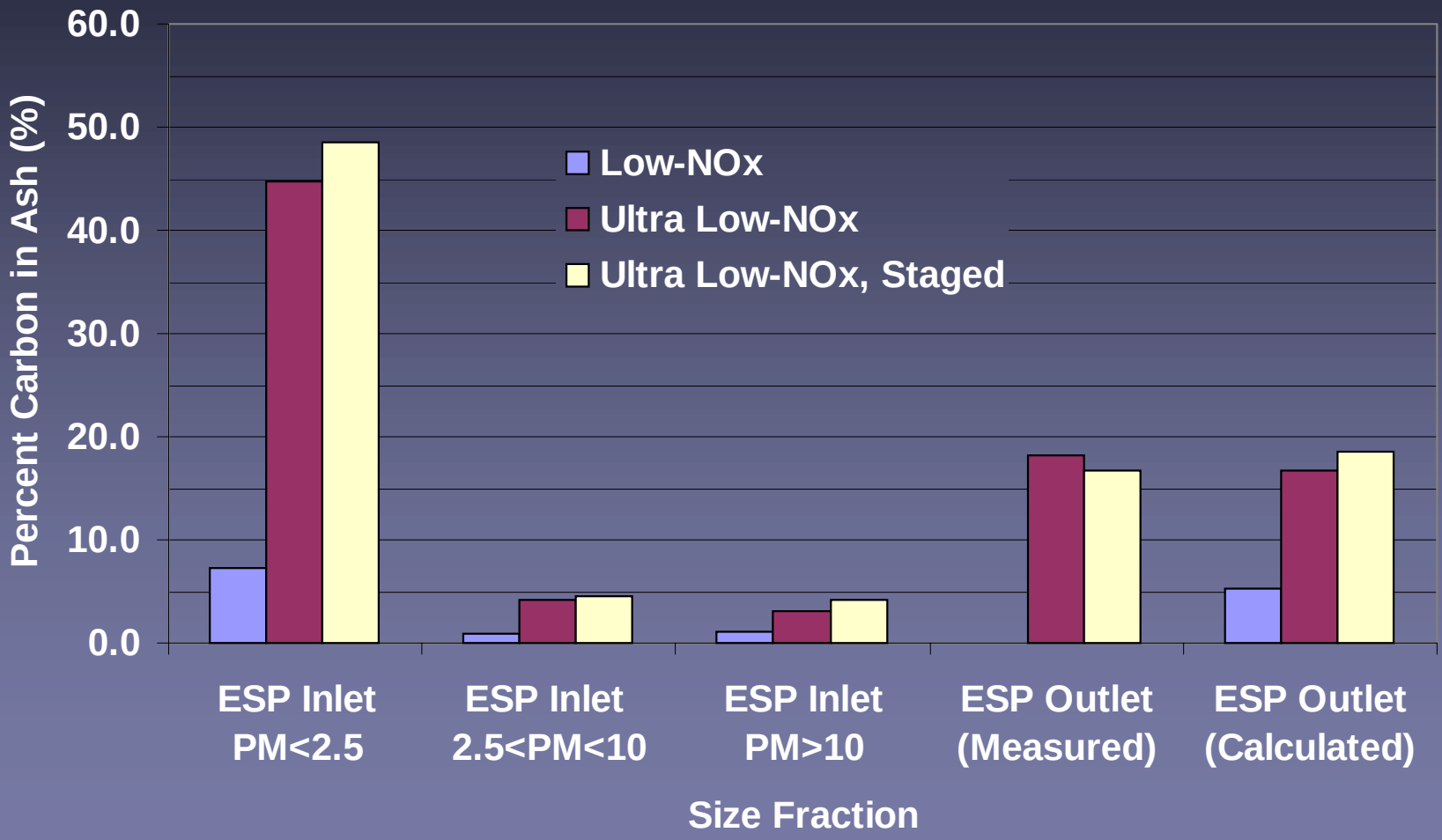
Fly Ash - ESP Inlet



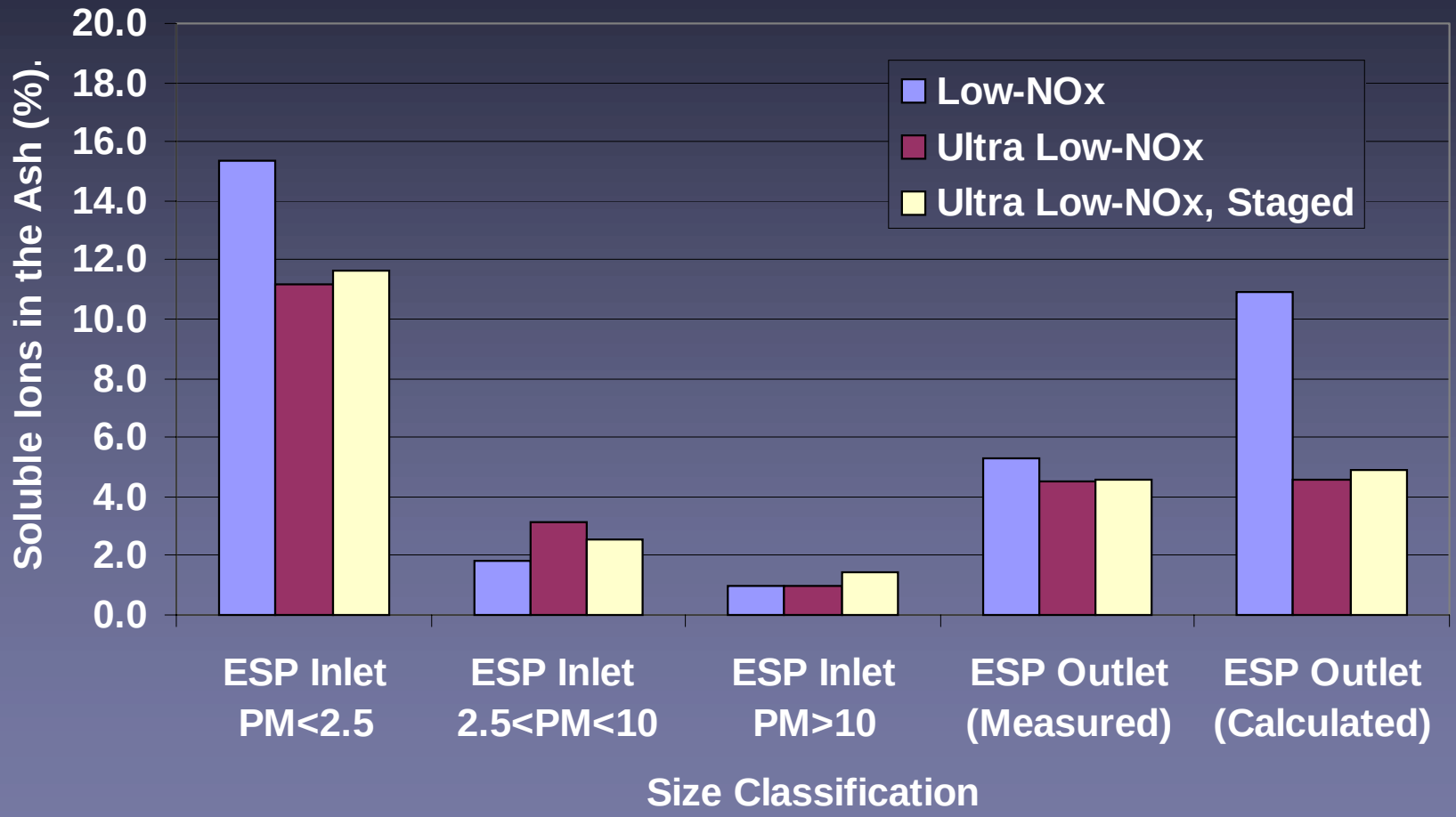
Fly Ash - ESP Outlet



Carbon in Ash by Size



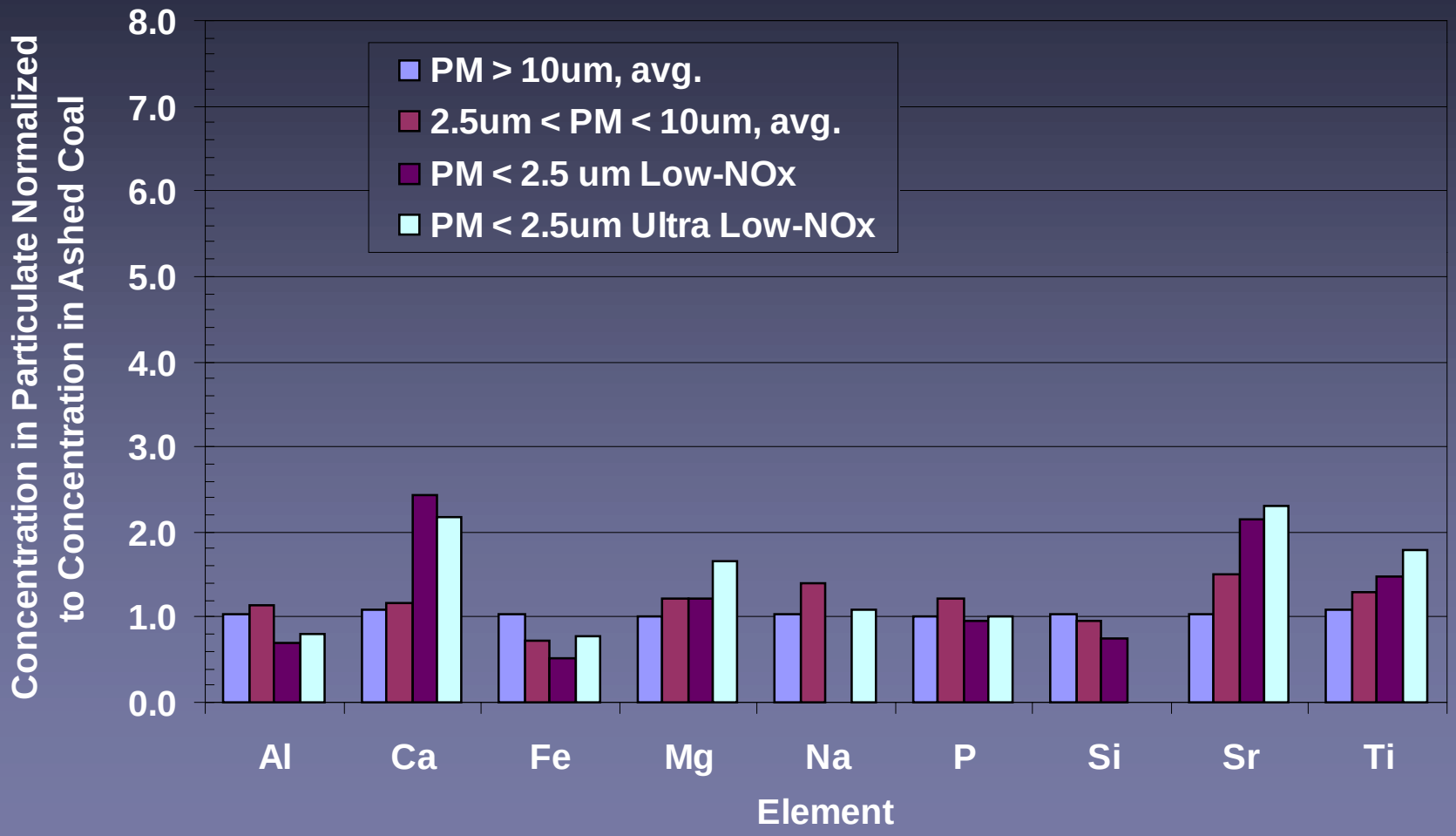
Soluble Ions by Size



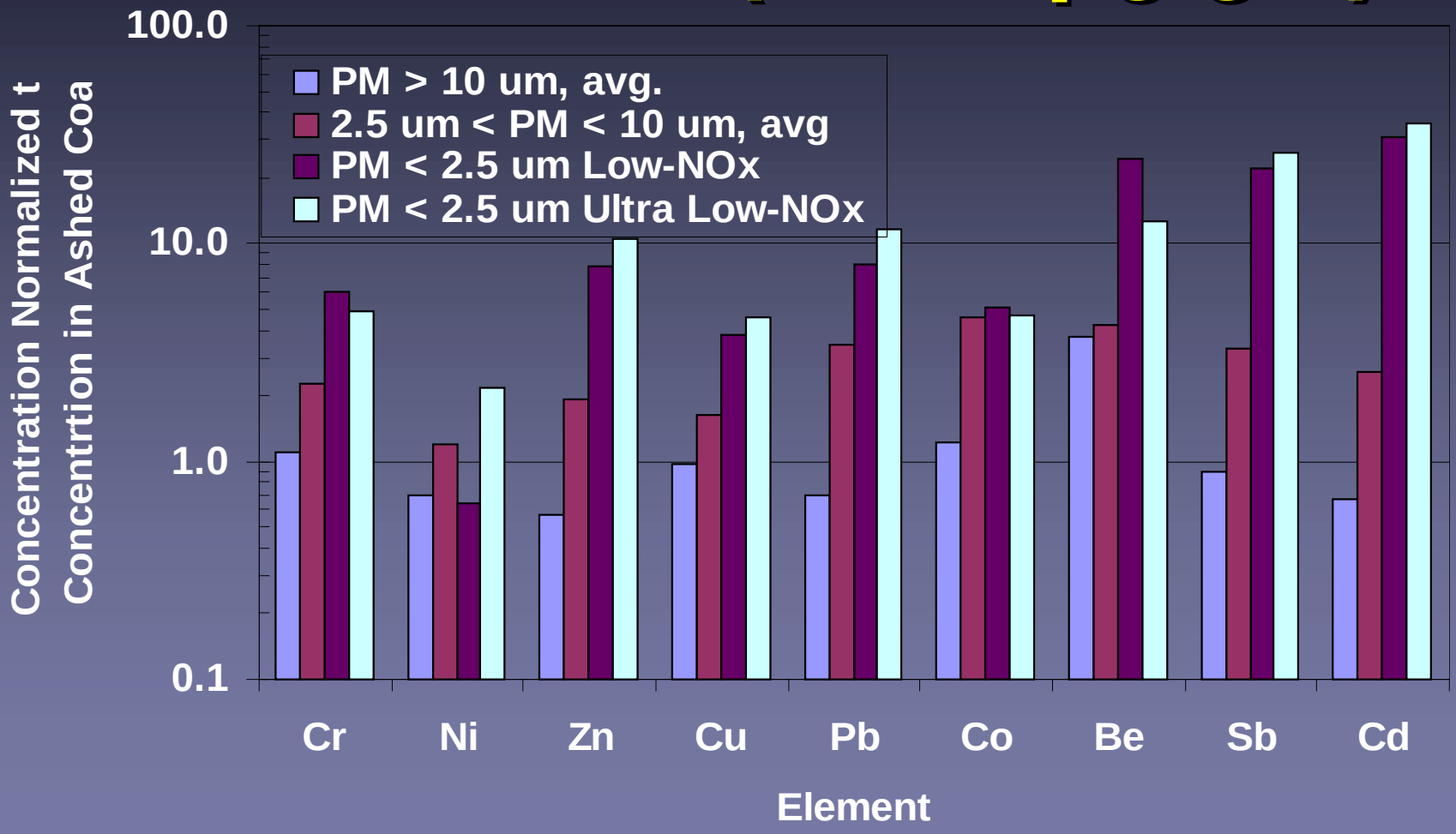
What Does This Show

- ESP emissions
  - Increase for ultra low-NO_x due to PM > 2.5 µm
  - Increase in average carbon in ash due to PM<2.5 µm, and PM> 2.5 µm
- ESP emissions can be calculated given:
  - Mass distribution at ESP outlet
  - Composition by size at the ESP inlet

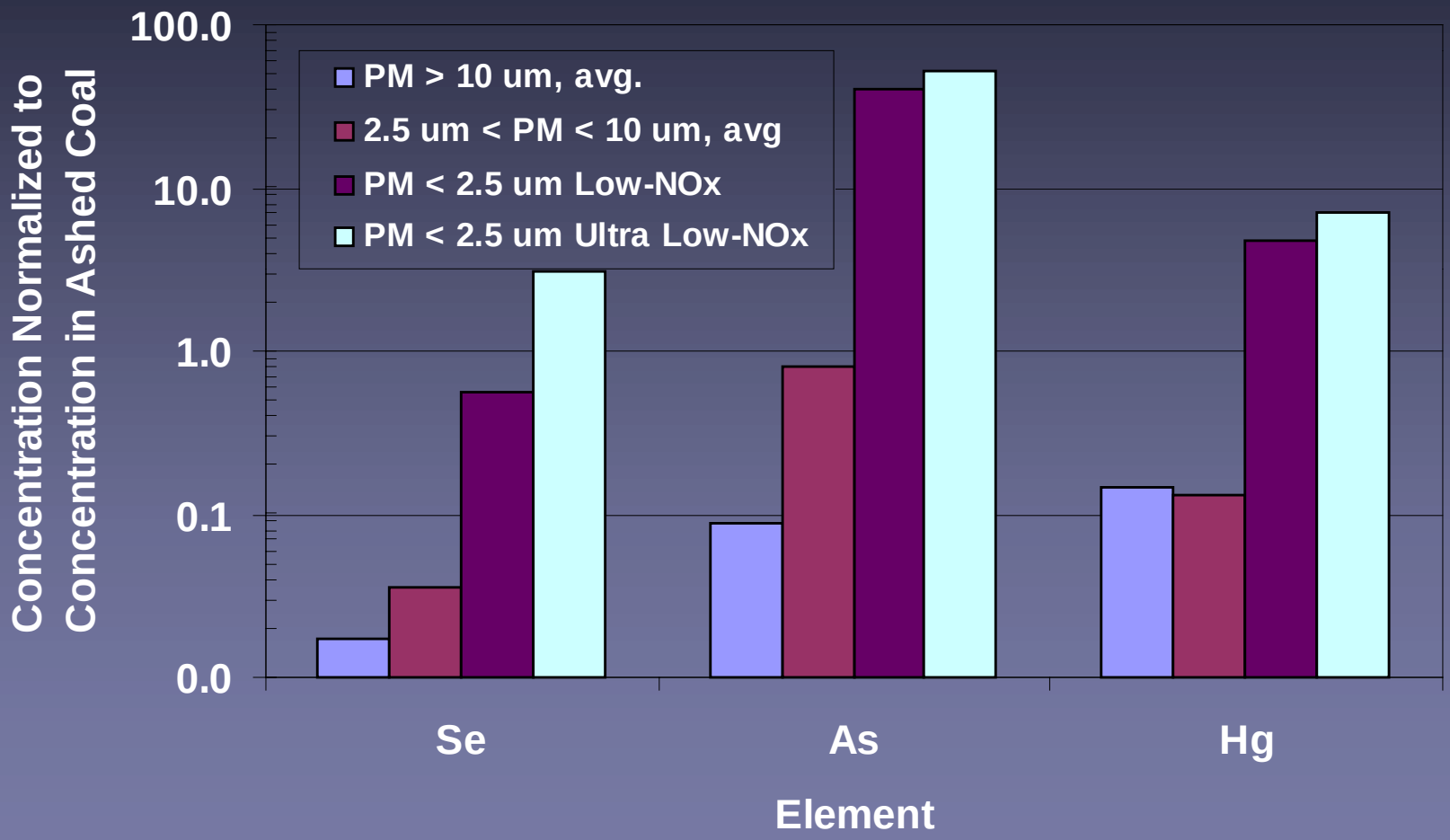
Major Elements (>500 µg/gm)



Trace Elements (< 500 µg/gm)



Volatile Trace Elements



Summary

- Average ESP outlet concentration is a weighted sum of concentrations by size
- ESP emissions increased for ultra low-NO_x conditions
  - Increase in PM > 2.5 microns
- Carbon in ash increased for ultra-low NO_x
  - Strongly size dependent
  - Increase due to PM < 2.5 μm, and PM > 2.5 μm

Summary (con't)

- Mercury in ash increased for ultra-low NO_x
  - Carbon is the likely factor
- Specific results are likely coal dependent
  - Ionic species and carbon